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Reducing Nosocomial Infections in Surgical ICUs in Sri Lanka: Co-Creating a Safety Culture Using an eHealth Intervention

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Abstract. Nosocomial infections are a major public health risk more prevalent among vulnerable patients in intensive care units of lower and lower-middle income countries. Despite advances in health care, the prevalence of nosocomial infections is alarming. The reasons for these infections are multifactorial and include organisational, cultural and individual factors. This paper discusses the findings associated with research undertaken in six surgical intensive care units in Sri Lanka to evaluate the impact of an eHealth system prototype in contributing to the improvement of hand hygiene compliance and thereby reduction of nosocomial infections. Key findings include the necessity of reconsidering the way of calculating nosocomial infection rates, the importance of coupling interventions to feedbacks on outcomes and the role of the leaders as role models in inculcating positive behaviours.

Keywords. Nosocomial infections, User Centred Design, eHealth, Hand Hygiene compliance.

Introduction

Nosocomial infections have been a global concern throughout the health sector[1]. Rates of nosocomial infections are higher in intensive care units where patients' immunity is low[2]. Reasons contributing to nosocomial infections are diverse and include poor hand hygiene compliance, irrational antibiotic usage, improper setup of the hospitals, and poor general cleanliness of hospital.

The problem is aggravated by limited facilities available in hospitals in lower and middle-income countries[3] and socio-cultural factors such as hierarchy. Poor hand hygiene compliance is considered as one of the main reasons for continued high nosocomial infection rates[4]. Numerous interventions aimed at improving hand hygiene have only been partially successful[5].

eHealth is known to facilitate inculcation of safety culture among health professionals. Distinct aspects of patient safety, including improving patient handover, facilitating antibiotic stewardship, and reducing prescribing errors have been achieved by using eHealth as a facilitator[6-9]. However, eHealth, if not utilised properly, may lead to harmful consequences, and large gaps have been identified in what eHealth perceive to be doing and what it actually does [10, 11].

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eHealth systems when developed utilising user-centred design have managed to be more robust and are capable of being more effective and efficient [12, 13]. This research aimed at using the same principles to investigate whether user-centred design and eHealth can contribute to increased hand hygiene compliance rates and thereby reduce nosocomial infections.

1. Methodology

The research was conducted as a four-phased case study in six surgical intensive care units(SICU) in Sri Lanka.

The first phase studied patient records of all admissions (n=600) to the selected SICUs, during the year 2013, to collate diagnosis, determine nosocomial infection rates and antibiotic usage patterns and record investigation findings indicative of infections.

The second phase consisted of several sub-phases. Multiple observation sessions(n=15) were conducted to calculate hand hygiene compliance rates of the staff and observations were documented using WHO hand hygiene observation tool [14]. Further, the staff were interviewed(n=16) to determine their perceptions and attitudes towards the reduction of nosocomial infections and especially to determine their perceptions and attitudes towards improving hand hygiene compliance. Interviews were used as an opportunity to identify possible interventions contributing to the reduction of infections and gathering requirements for the interventions. The intervention; android app for peer monitoring of hand hygiene compliance was identified and developed from the requirements gathered during this phase.

The intervention was introduced to the two test sites on completion of phase two on 1st July 2016. Phase three was a repetition of phase two where users were interviewed(n=10) to determine changes in attitudes and perceptions towards nosocomial infections. Phase four was a repetition of phase one where patient records(n=300) of post-interventional one year were studied to determine the patterns in diagnosis, nosocomial infection rates, antibiotic usage and investigations to determine the changes associated with interventions [15]. Thematic analysis was conducted for interviews to identify themes associated with the interview, while quantitative data was analysed to identify the percentages, central tendency, deviations and range of the analysed attributes. Data for each phase was analysed individually and then compared with the other phases. Data of phase one with two and three with four were compared to see whether interview findings are supported by quantitative data, while data of phases one and two were compared with that of phases three and four to determine changes associated with the intervention.

2. Results

Nosocomial infection rates were calculated using CDC guidelines for nosocomial infections. Information collected from the patient charts prior to intervention suggested around 12% of patients who were admitted to the SICUs had positive cultures and around 9% had established nosocomial infections.

Despite recording below predicted infection rates, 60% of patients recorded at least one positive sign, symptom or investigation indicative of an infection, initiated after completing at least 48 hours in SICUs. However, due to non-availability of appropriate

culture reports and limitations in eliciting required clinical findings, a diagnosis of nosocomial infections could not be established in most of these patients.

There were 1266 moments of hand hygiene observed using the interventional application. At the start of the observations, hand hygiene compliance rate was 35%. Post-interventional first few months did not show a significant increase in compliance rates. However, the introduction of regular feedbacks midway into the intervention saw a significant increase in compliance rates from around 37% to more than 55%.

The post-interventional overall compliance rate for staff was around 45% with nurses recording highest compliance rate of 55% while some allied health professionals recorded very low compliance rates. Compliance rates were low during the busy hours while compliance rates were high during the evening, night and early morning.

Table 1. Compliance rates according to the time of the day

Time interval (Hours of the day)	Compliance Rate
00:00 – 04:00	65%
04:00 - 08:00	47%
08:00 – 12:00	44%
12:00 – 16:00	43%
16:00 - 20:00	46%
20:00 – 24:00	52%

During the interviews, most of the staff interviewed were aware of the poor hand hygiene compliance amongst them. They considered poor hand hygiene compliance as one of the main factors in causing nosocomial infections. All saw the need for interventions to improve hand hygiene compliance. However, the approaches suggested in this were different among the staff. Some suggested the need for more education and regular visits by infection control staff while some suggested changing of hand rubs. However, the majority thought an intervention which would monitor hand hygiene compliance rates of the staff among themselves would be the best solution.

While being aware of poor hand hygiene compliance, their perceived compliance rate before the intervention was around 60%. The intervention together with regular feedbacks resulted in giving better insights into the real initial compliance rate which was around 35%.

Organizational and cultural factors such as hierarchy also played a significant part in poor hand hygiene compliance. Some of the staff members insisted their inability to clean hands after each encounter with patients due to time constraints and uncomfortability associated with using hand rubs. Further, staff tended to follow their manager's patterns, especially, if a medical specialist has a higher compliance rate, it was evident that the medical officers of that speciality had similar compliance rates.

3. Android application

Findings from the phase one of the research prompted the necessity to have an intervention. The application was based on the requirements identified in the second phase. The basic framework was based on WHO hand hygiene compliance monitoring tool. However, user-centred design and Agile software development methodologies were used throughout the development lifecycle. These methodologies transformed the basic application structure to incorporate local requirements and ways of improving efficiency and accuracy in data gathering processors. The design team consisted of Microbiologists, Infection Control staff, Medical Officers, Nurses of ICUs and Allied

Health staff. Regular stakeholder meeting and frequent prototyping saw a rapid versioning where three prototypes were developed before selecting the fourth, implementable version. Each version was tested with the stakeholders for usability and accuracy. The developed application included a login screen, where details of the observer are recorded. Further, each observation session is started with the recording details of staff who are being observed. The application allows up to four staff to be observed at a given time. For each moment of hand hygiene, the observer records the moment number, compliance level and optionally the usage of gloves.

4. Key findings and discussion

Based on the data collected during the research, several key findings were elicited. Due to data of the fourth phases are still being analysed, findings are inconclusive. However, these findings give a clear direction on the outcome of the research.

The current definition of nosocomial infections requires fulfilment of several steps for confirmation or exclusion of nosocomial infections. However, in a practical setting, not all those steps are always completed. This gap in theory and practice hinders the ability to establish a diagnosis of nosocomial infection. However, empirical evidence suggests the presence of nosocomial infections. Therefore, identifying cases with "signs, symptoms and investigations indicative of infections" to complement nosocomial infection rates will establish wholistic view of the infection rates.

Differences in compliance rates according to the time of the day suggest a connection between compliance rates and workloads. This relationship indicates a necessity of having novel ways of maintaining compliance rates during busy hours.

The mere introduction of interventions seems to have not impacted the compliance rates. The improvement of compliance on introduction of feedbacks suggests connection between having insights of the situation and changing behaviours based on those insights. The connection between compliance and managers behaviours implies the necessity of inculcating proper behaviours in managers which will improve overall compliance rate of the staff reporting to the manager.

Multiple stakeholders involved throughout the research, especially, Microbiologists, Infection Control Staff, Medical Officers, Nurses and Allied Health staff enabled co-creation of safety culture by self identification of the problem and having a combined effort in finding solusions to the problem.

5. Limitations

Findings communicated in the paper are confined to data collected up to the third phase of the research. The impact of the intervention on nosocomial infection rates and rates of cases with at least one sign symptom or investigation indicative of infection can only be elicited on completion of the analysis of phase four data. Moreover, as number of sites and sample sizes were small, there is an inability to generalise quantitative findings of the research. However, quantitative findings considered in conjunction with qualitative findings are helpful in building an overall understanding of the outcome of the research.

6. Conclusion

This research, is currently in the intermediate phase of data analysis. However, intermediate results elicits the role of the combination of eHealth and regular feedbacks in improving behaviours associated with the reduction of nosocomial infections. Moreover, it has demonstrated the link between higher workload and reduced compliance rates. Further, it has discovered the necessity of introducing new ways of calculating nosocomial infection rates to complement current ways of eliciting infections to get a more complete and comprehensive idea of the incident rates.

Once complete results of the research available, another similar paper will discuss the conclusive evidence in support of key findings of this research.

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